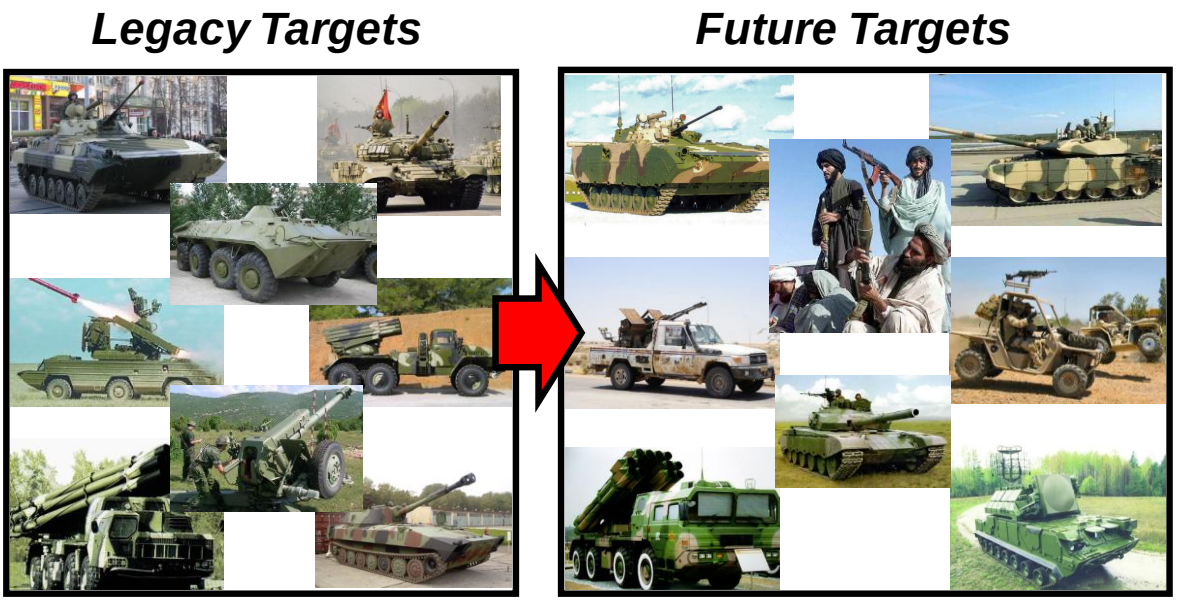
Future Ground Requirements: 2012 and Beyond



Prepared by:

Project Manager for Instrumentation, Targets and Threat Simulators

Targets Management Office

Redstone Arsenal, AL 35898-7458

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FY11 ASA(ALT) Study Proposal

Future Ground Targets: 2012 and Beyond

The following report explored the current status of target requirements and availability and investigated how future test arrays will be affected with new and modern technology. The report derives a path forward for equipping the Army Test and Evaluation (T&E) community with relevant Ground Targets for use in FY12 and beyond.

Recommendations, comments, or requests to disseminate this document may be submitted directly to the following:

Targets Management Office

SFAE-STRI-PMITTS-Q (Robbin Finley)

Building 3203, Hercules Road

Redstone Arsenal, AL 35898

Robbin Finley, Lead Project Director

US Army, Targets Management Office

Mr. Bruce Truog, Deputy Director

US Army, Targets Management Office

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Finley, Robbin
Sanders, Jeff

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
PM, ITTS Targets Management Office
ATTN: SFAE-STRO-PMITTS-Q
Building 3203, Hercules Road
Redstone Arsenal, AL 35898

8. PERFORMING ORGANIZATION REPORT NUMBER
n/a

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
HQDA, G8
ATTN: DAPR-ZXR (RITA MCCASKILL)
2530 Crystal Drive, Taylor Bldg
Arlington, VA, 22202

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14. ABSTRACT
The current fleet of ground targets is based heavily on Russian built battle tanks, infantry fighting vehicles, and armored personnel carriers (circa 1970s) with a recent influx of American made technical vehicles. Do we maintain an emphasis on Russian armored targets? Do we need weaponry from other countries? Do we put additional emphasis on current scenarios and introduce additional irregular warfare assets? This study will explore these questions and in coordination with Army Test and Evaluation Command (ATEC), intelligence agencies and Program Managers (PMs) derive a path forward for equipping our troops with relevant ground target threat targets for FY 12 and beyond.

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1.0 SUMMARY

This report was prepared by the Targets Management Office (TMO) for the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT). This report covers projected Army long-term requirements for ground targets to support Test & Evaluation activities. The content of this report is unclassified and was obtained from open sources and a separate classified addendum was generated. The requirements period that the results in this report cover is years 2012 to 2030.

Army target requirements are rapidly changing with the new US military strategic plans to shift focus to South Asia and the Middle East and have a greater focus on irregular warfare such as counterterrorism and counterinsurgency operations. This, combined with an increased importance of cyber warfare in future conflicts has shifted Army target requirements away from replicating the traditional NATO/Soviet Union Western European conflict which has been the paradigm for decades. While future Army target requirements will still include targets from the former Warsaw Pact, other targets and test requirements will have to be incorporated into future test planning to replicate realistic battlefield environments for developmental Army systems. Future Army test range targets will have to have the latest technologies in protection systems (both passive and active) to test future Army weapons and be fully electronically operational (computers and communications) to evaluate future Army cyber-warfare capabilities. In addition to the need for more advanced vehicle targets there will be a need for testing against personnel targets and representations of irregular forces in urban environments. The modern political climate has resulted in the need to minimize civilian collateral damage and this has resulted in the need to test non-lethal weapon systems against personnel targets as well.

2.0 INTRODUCTION

There is a constant and prevalent need in the Army T&E community for ground targets. Any developmental weapon or sensor system that must undergo any type of field testing will require targets to either engage or detect. From Webster's Dictionary, the definition of a target is "something or someone fired at or marked for attack ". Within the context of this study a target is a battlefield object of interest to a sensor that is to be detected, recognized or identified, and then possibly engaged with an Army weapon system. In the scope of this report the term sensor could mean everything from human sensory inputs to complex, multi-mode sensor platforms.

There have been significant changes in target requirements for T&E as Army weapon systems transition from the traditional heavy forces European battlefield scenario to a wide range of lower intensity conflicts with a significant asymmetric warfare component. There are two

documents that will be used in this report to define and infer future Army T&E requirements. These two documents are the January 2012 Strategic Department of Defense (DoD) Guidance Document[1] and the February 2012 Army Priorities Document[2]. The Strategic Guidance Document has numerous data points relevant to future Army test requirements and these include:

- a transition of focus from Western Europe to Asia and the Middle East,
- development of a long-term strategic partnership with India,
- development of innovative, low cost, and small footprint approaches to achieve security objectives,
- countering the proliferation of weapons of mass destruction (WMDs)
- counter-terrorism and irregular warfare is a primary mission of the US armed forces
- the ability to conduct large scale operations in one region with lesser scale operations in a second region,
- and the ability to conduct stability and counterinsurgency operations is a primary mission.

All of the above was summarized into the primary missions of the US armed forces with the Army-relevant ones being counter-terrorism and irregular warfare and deterring and defeating aggression. The Asian geographic references were more specifically described as "an arc extending from the Western Pacific and East Asia into the Indian Ocean region and South Asia". A specific mention of China as an emerging regional power was made as well as a specific mention of Iran.

The February 2012 Army Priorities Document was, as expected, consistent with the DoD strategic guidance document with an additional level of detail regarding near term development programs. Topics relevant to Army test requirements were:

- enhancement of Army activities in the Asia-Pacific region,
- resetting and modernizing the force with specific mentions of the Ground Combat Vehicle (GCV) and Joint Light Tactical Vehicle (JLTV) programs,
- GCV is critical to the Army's ability to conduct fire and maneuver in close quarters fighting in complex terrain,
- and the Army's new information Network remains the top modernization priority.

While it is impossible to predict the future with any certainty, recent events and the strategic plans mentioned above certainly identify coarse trends in ground target requirements to support Army T&E activities. These trends will include the inclusion of geographically relevant targets into Test and Evaluation Master Plans (TEMPs), a user focus on networked systems fighting irregular forces in complex (most likely urban) terrain, and a general shift to fewer heavily armored targets and more personnel and lightly armored targets. It is important to note that no target categories should be eliminated as the full spectrum of target types will always be needed

but the relative amounts of types of targets in TMO inventory will most likely need to change to more efficiently meet future T&E needs.

3.0 METHODS, ASSUMPTIONS, AND PROCEDURES

This study was accomplished using totally open source information obtained primarily via the internet and through the personal archives of the primary author. The process for determining future Army T&E target requirements is shown in Figure 1. The process began with the determination of known Army test requirements by researching existing and near-term Army development programs. Along with this effort the ground vehicle weapon system inventories of geo-politically relevant countries were studied. The principal members of these ground vehicle inventories were tabulated along with their numbers in existence and current and projected production status. After the completion of the open-source research an unclassified requirements report was generated. With completion of the unclassified report, Joint Counter Force Assessment (JCOFA) reports from NGIC were studied, requirements were determined from these reports, and a classified appendix was generated.

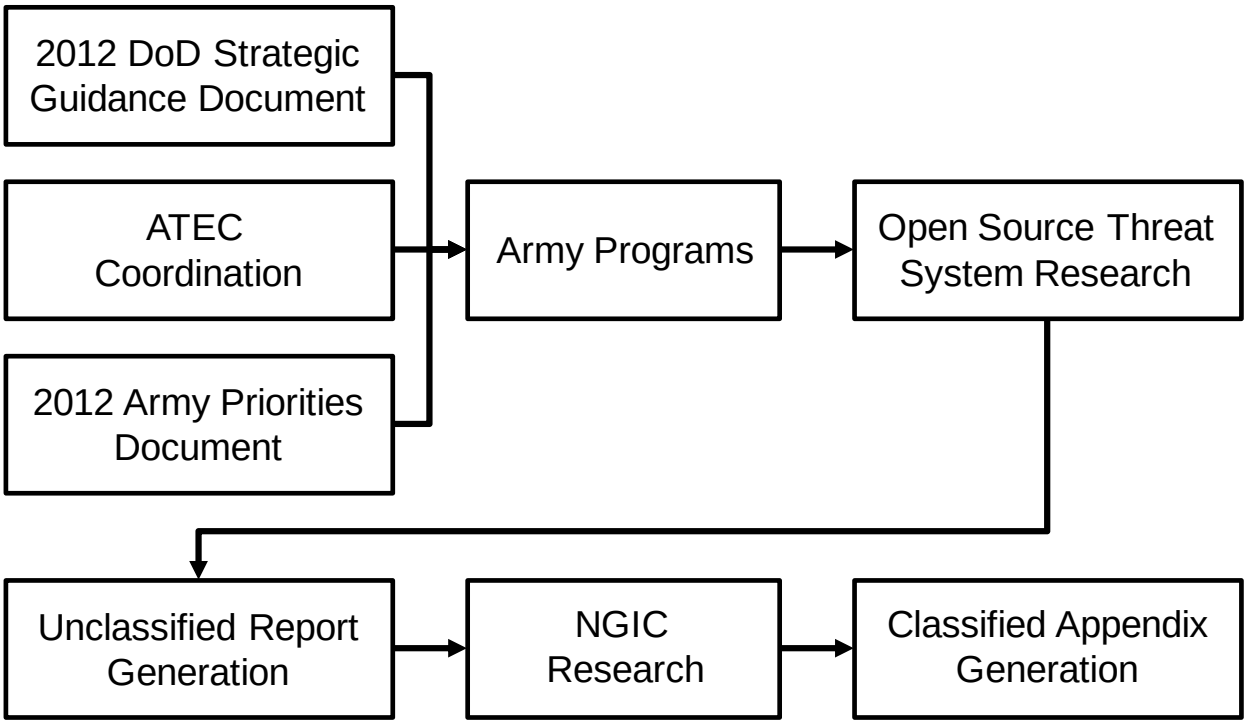


Figure 1. Requirements Generation Process.

There are geopolitical regions on the planet that for different reasons are probable areas of future deployment of US Army weapon systems. The selection of a country as geo-politically relevant

was based both on historical issues and future projections. Many of these countries of interest do not have an established military industrial complex but import their weapon systems from countries with Cold War era military industries and while the Unites States isn't projected to go to war with these Cold War opponents in the future, the countries and forces we may face in the future could be armed by them. A prime example of this is Russia. The 2012 DoD strategic guidance document specifically mentions a continued cooperative engagement with Russia and the development of a closer relationship in areas of mutual interest. However, Russian equipment makes up the majority of Army T&E target inventories and this might imply a focus on Russia as the primary US adversary in future conflicts. While there are certainly many legacy holdover target requirements from Cold War scenarios this may be appropriate for the future as Russian weapon systems are highly proliferated to countries of current and future interest to the United States military.

The proliferation issue is of great concern and is an element of the ground vehicle inventory analysis mentioned above. Governments and forces in regions of interest to the United States military not only receive weapon systems (and designs) from nations of the Former Soviet Union (FSU) such as Russia and Ukraine, but from the United States and its allies such as France, Great Britain, and others. China is making major advancements in its ability to manufacture modern weapon technologies and with its long history as a manufacturing exporter China can be expected to be a major contributor to weapon system proliferation in the future. While it may seem odd to mention the United States as a weapon system proliferation concern to Army developmental systems, events such as the Arab Spring and the general political upheaval currently occurring in the Middle East could lead to future conflicts with countries like Egypt which has large inventories of US weapon systems such as the M1 Abrams Main Battle Tank (MBT). Even if conflicts with countries such as Egypt do not occur it is certainly conceivable that they could proliferate their inventory of US systems to countries where conflicts could occur.

This possibility of US forces facing US ground vehicles on a future battlefield brings up an opportunity for future Army T&E cost savings. If surplus US equipment could be used as signature and/or lethality surrogates in Army T&E it could significantly reduce the cost of providing ground targets for T&E events. Surplus US equipment and an existing logistics and maintenance infrastructure could be leveraged to support Army T&E needs at a large cost savings to developmental programs. However, justifying the use of a surplus US ground vehicle as a threat target surrogate will be a complex process and will have to be addressed on a case-by-case basis in cooperation with the Army intelligence community. An initial analysis of surrogate options is included as part of this report.

4.0 RESULTS AND DISCUSSION

The results of this report are summarized in the following subsections. The process starts with the listing of known, near-term, Army development programs. The process then continues with the delineation of ground target systems by country of residence, number in existence, and current and projected future production status. After the ground target inventory analysis a discussion of irregular warfare target requirements is covered, this analysis focuses on personnel and other targets including counterterrorism and counterinsurgency targets. The results section continues with an analysis of target surrogate concepts which will describe possible options for meeting future test requirements at reduced costs to the Army T&E community. The results section concludes with joint service target requirements which could be met by the development of targets to meet Army T&E needs.

Prior to discussion of results, basic target requirements will be covered so that the results of this report can be placed in the proper context. The first topic to be discussed is "what are the fundamental characteristics of a target?" While targets can be anything from tanks, to emplacements, to personnel this question will be addressed from the point of view of the designer of a modern military vehicle. Figure 2 and Figure 3 show the basic design philosophy of a modern military vehicle. Modern military vehicle design centers on the concept of survivability. It can be argued that this design philosophy hasn't always been followed, especially by FSU vehicle designers, but modern Russian and Ukrainian vehicle designers are currently aggressively addressing this approach to vehicle design. How this design philosophy impacts T&E target requirements is primarily in the two main areas of target signatures and lethality.

If a US weapon system is being designed to defeat a foreign ground system it must go through the classic target engagement process of target detection, acquisition, recognition, identification, tracking, and finally the defeat of all of its defense mechanisms. The detection through tracking processes exclusively involves target signatures in a variety of physics regimes. The defeat of defense mechanisms can involve signatures in the case of countermeasures but is primarily associated with the goal of a violent demise of a target through the application of chemical and/or kinetic energy. However, it is important to note that non-lethal weapon system testing is a recent requirement that can be expected to extend far into the future. When defining the requirements of a target to support Army T&E this entire target engagement process must be considered and the target used in a test must be representative of a threat at all stages.

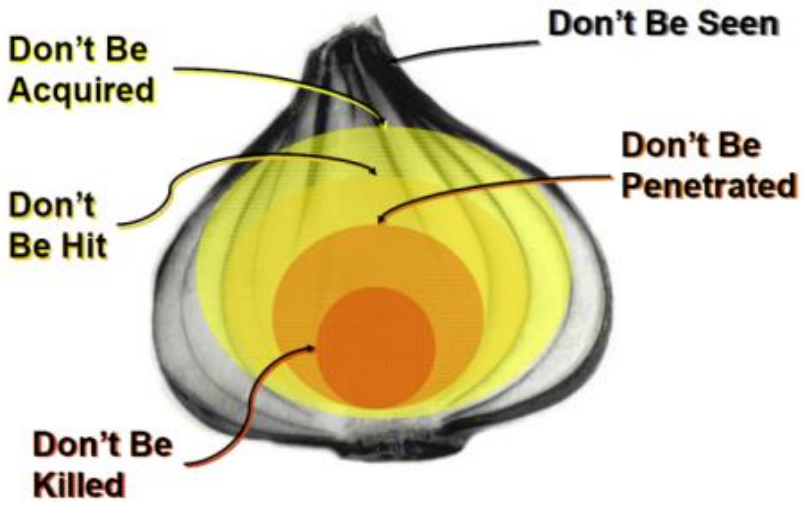
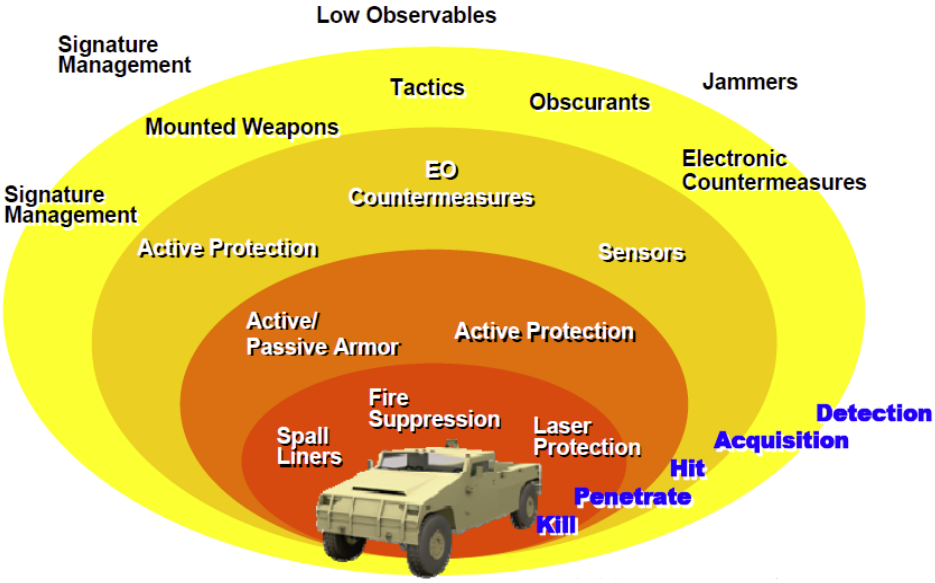


Figure 2. Ground Vehicle Survivability Design Philosophy



Figure

Figure 3. Ground Vehicle Survivability Layer Details

The survivability layer details shown in Figure 3 are an excellent guide to fundamental ground vehicle target requirements for Army T&E. Depending on the system under test (SUT) a target may be required to have any number of these components to properly stimulate and stress the SUT's sensors and sub-systems. As an example of how all of these target components come into play in a test event a hypothetical scenario of an unmanned aerial system (UAS) engaging a ground target with a missile will be used. The scenario begins with the UAS doing a large area search with its sensor suite which will require that the target present the correct signature in all sensor regimes. Low observable and signature management aspects of the target dominate this

aspect of the scenario. Once the target is detected and acquired as a target it will be tracked until it can be recognized as a target of interest and identified as a threat to be engaged with an onboard missile system. Describing all possible missile engagement scenarios is beyond the scope of this document but once the engagement begins the missile engagement is impacted by off-target factors ranging from tactics, countermeasures, and active protection systems. Countermeasures can shift target aim points and active protection systems (APS) can destroy an incoming missile before impact. Future missile designs will include extreme end-game maneuvers to avoid destruction by an APS. If an SUT has end-game maneuver capabilities targets will need to have active and working APS capabilities to fully stress an SUT. Once the missile impacts the target the dominant factor is the armor of the vehicle which can be comprised of both active/reactive armor and passive armor. Reactive armor is becoming pervasive in armored vehicle designs and will need to be included on targets for Army T&E when lethality is a factor to be included in a test.

As mentioned above, how a target stimulates an SUT revolves completely around its signature(s). The official DoD definition of signature is "the set of recurring features that uniquely identify a system, event, or activity". System signatures have already been discussed but signatures of events and activities have become much more relevant in recent years especially in regards to counterterrorism and counterinsurgency operations. Intelligence, Surveillance, and Reconnaissance (ISR) systems such as UAS platforms are not just looking for battlefield targets such as vehicles and weapon systems but are increasingly involved in monitoring an asymmetric battlefield where personnel play a significant role. Signatures of events such as explosions and activities such as the deployment of Improvised Explosive Devices (IEDs) will likely be critical elements of future test activities. Future test capabilities will need to accommodate this type of sensor stimulation in a realistic manner.

4.1 US Army Developmental Programs of interest and Army Technology Development Projections

From 2012 to 2030, the US Army has or will have a wide range of systems under development or being upgraded that will have target requirements. These systems will include armored vehicles, missile systems, helicopters, and UAS.

4.1.1 Short term Army target needs.

Systems currently undergoing T&E that will have short term target requirements include:

- Gray Eagle UAS
- Apache Block 3

- Javelin Stockpile Reliability Program (SRP)
- Switchblade
- Brigade Combat Modernization (BCM)
- Robotic Unmanned Sensors

These programs are already testing against targets and due to the lead time on targets their test needs will not be impacted by anything in this report. The Air Force has current test requirements for the Small Diameter Bomb (SDB) program and Navy and Marine Corp requirements were not determined as part of this report.

4.1.2 Mid-term Army Target Needs

Mid-term Army developmental programs (out to 2020) that will require targets include:

- Ground Combat Vehicle
- Joint Light Tactical Vehicle
- Soldier Systems
- Non-lethal Weapon Systems

The mid-term Army target requirements are primarily driven by the Ground Combat Vehicle (GCV). At the time of the generation of this report there are no unclassified test requirements for the GCV program but some can be inferred. Very little or no reliable unclassified information is available regarding the GCV but the primary purpose of the GCV is described as being to carry a squad of nine soldiers on the battlefield and engage a wide range of enemy combatants. If the purpose of the GCV is, as stated, to replace the M2 Bradley Infantry Fighting Vehicle (IFV) it will be required to engage any and all ground targets ranging from MBTs to personnel with a primary target being an IFV such as the Russian BMP-2. Of note is the mention in the open literature of the possibility of the GCV employing non-lethal weapon systems. The GCV is currently planned to be in production and available to Army units in 20XX, which means that any testing that will require targets will have to occur prior to that.

The JLTV is planned as a replacement for the High Mobility Multipurpose Wheeled Vehicle (HMMWV) and can be expected to carry a variety of light and crew-served weapon systems as well as sensors. Target requirements for the JLTV program will be relatively minimal and will most likely be met by personnel and tactical vehicle targets along with a non-lethal weapon system test need.

Soldier systems that will require targets will most likely be comprised of man-portable sensors networked to fire support units. These will most likely be in the form of multi-function sensors and target designators. Even though the fire support units may be already-fielded systems the networked sensor will require stimulation with a target so that the proper information can be transmitted to support units.

Non-lethal weapon systems are a new category of personnel target that requires significant additional instrumentation for inclusion in a test. Traditional personnel targets only require hit sensing which can be met with commercial off the shelf (COTS) vibration and acoustic sensors. Non-lethal weapon systems will potentially utilize non-kinetic energy such as acoustic, light, or microwave energy which will need to be measured in real-time during a test to determine if a personnel target has been incapacitated and to what level. Any personnel target used for non-lethal weapon testing will require an individual, calibrated sensor suite to address these requirements.

4.1.3 Long Term Army Target Needs

Long-term Army programs past 2020 are difficult to project but are likely to include:

- new sensor systems and platforms (all modalities)
- new unmanned systems or upgrades of existing systems
- new missile systems or upgrades of existing systems
- upgrades of heavy armor and artillery systems
- upgrades of soldier systems
- cyber warfare

New sensor system development, particularly Electro-Optic (EO) sensors, will likely be a significant element of long-term Army technology developments. ISR and persistent surveillance will be a major element of any counterterrorism or counterinsurgency activities and these types of activities have been defined as a focus for the Army of the future. EO sensors will also likely be transitioning from single spectral bands to multi-spectral or hyper-spectral sensing modalities. This impacts target requirements in that these types of sensors will be sensing the spectral properties of target surfaces which means that the targets will need to be spectrally threat representative. Older targets that have been in US inventory for years may come from the wrong country of interest and have the wrong surface optical properties or the target's surface optical properties may have aged and become non-threat representative. Spectral sensors will be able to detect these differences and this issue may have to be addressed in future target requirements as the Army deploys spectral sensors. Sensors of interest will not just be on aerial or ground platforms but will be on missile systems also. Future Army missile systems will be multi-mode and include both EO and Radio Frequency (RF) sensors and target requirements will be driven by both of these sensor's needs.

Even though the Army is planning on transitioning to a smaller, leaner, more reactive force structure the army will have a significant heavy armor component for decades to come. History has shown that successful armored vehicles have extremely long lifetimes and the M1 Abrams MBT will most likely be the MBT of choice for the US Army over the next two decades. In addition to its success-based longevity the US military budgets of the near future will not likely

be able to absorb the development of a new MBT for the Army. Since the M1 will likely be too expensive to replace and will likely be around past 2030 it will need to be upgraded. M1s are constantly being refurbished and upgrades are often part of the refurbishing process. At some point a major upgrade will occur that will require T&E with targets, most likely as part of a combined test with other systems.

All of the above mentioned Army systems that either are planned or hypothesized for development will be part of a computer network in a System of Systems (SoS). Cyber warfare has already become a major component of modern conflicts and can be expected to increase in importance in the future. All new military vehicles are computerized to some extent and many if not most are being networked into battle management command and control systems. It is not inconceivable that at some point in the future a requirement will exist to have a fully-functional threat system complete with command and control communication systems so that an Army system under test will need to test some form of cyber warfare or communications jamming capability.

4.2 World Ground Target Inventory Analysis

4.2.1 Target Class Member Summaries

The ground target inventory discussion will begin with the definition of the relevant classes of military ground vehicles followed by a description of the most relevant members of each class. The relevant classes of ground targets for this report are the following:

- Main Battle Tanks
- Infantry Fighting Vehicles
- Armored Personnel Carriers (APCs)
- Air Defense Systems
    - Surface-To-Air Missile Systems
    - Anti-Aircraft Artillery
- Artillery
    - Self-Propelled Howitzers (SPHs)
    - Towed Artillery
    - Multiple Launch Rocket Systems (MRLS)
    - Short and Medium Range Ballistic Missile Systems (SRBM/MRBM)
- Combat Support Equipment
    - Trucks and Cargo Vehicles
    - Reloaders and Transloaders

- Command, Control, Communication, Computing, and Intelligence (C4I)
- Engineering Equipment
- Electronic Warfare Systems

- Personnel and Crew-Served Weapons
- Asymmetric Warfare and Miscellaneous Systems
  - Technical Vehicles
  - Special Operation Forces Vehicles

Figure 4 shows example photographs of members of each class of target.

Figure 4. Classes of Ground Targets

Ranking battlefield elements for relevance to the Army mission is driven by the probability of encountering that target on a future battlefield as a target of interest. This probability is driven by the following factors:

- probability of the United States being in some type of conflict or potential conflict with the country of ownership of a given target,
- the number of a certain target in existence,
- and the probability that a certain target will still be on the battlefield of the future.

Even though Russia is no longer the primary US adversary, Russia is, and can be expected to be a primary source of weapon systems well into the future. China is catching up in weapon

technologies and with its growing industrial base and history of exporting they can be expected to play a large role in future weapon system proliferation. Both countries export weapon systems to countries with animosity to the west and/or with a high potential for political instability. In addition to this, there are extensive stocks of weapon systems left over from the cold war era that are either still in use or are being offered with upgrades to make them relevant on the modern battlefield. Therefore, Russia and China qualify as the primary potential sources for weapon systems during the time frame of this study. Many other countries including the United States are offering up weapon systems for sale and these are included in the analysis as weapon systems from the United States and long-time allies either are in the inventories of potential adversaries such as Iran, or could end up there in the future.

Main battle tanks are very important and possibly the most common targets to test against in that they represent the most challenging armor for a warhead or gun round to defeat, they are intended to lead formations in assaults, and represented the greatest threat on the traditional battlefield. With the future US military focus on non-traditional battlefield scenarios heavily armored MBTs will not be the class of target that US weapon systems will engage most often but still must be included in test planning for completeness. The future focus on small footprint conflicts, counterterrorism, and counterinsurgency will shift test requirements from testing against elements of heavy armored formations to a more dispersed, elusive, and technologically advanced threat. Figure 5 shows the top MBTs of interest worldwide. Table 1 contains data concerning the production parameters and proliferation of the MBTs shown in Figure 5. The quantity numbers in the table are very conservative and may be much higher for some of the entries.

Figure 5. MBTs of the Top Five Producing and/or Proliferating Countries of Interest

Table 1. MBT Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
T-90	5/5	1500+	YES	YES	YES
T-72	40+/20+	10,000+	YES	YES	YES
T-80	11/5+	5,000+	YES	YES	YES
T-62	30+/10+	5,000+	NO	NO	YES
T-55	90+/30+	10,000+	NO	NO	YES
Type 98/99	1/1	>800	YES	YES	YES
Type 85/96	2/2	1000+	NO	NO	YES
Type 69/79	10/5+	1000+	NO	NO	NO
M1	6/4	5000+	NO	NO	YES
M60	25/10+	10,000+	NO	NO	YES
Leopard	17/0	1,000+	YES	YES	YES

Figure 6 shows the IFVs of interest worldwide. While many countries are producing IFVs there are only two countries, Russia and China, which are building IFVs that are likely to proliferate to countries of interest to the US military. Table 2 contains data concerning the production parameters and proliferation of the IFVs shown in Figure 6. Of particular note are the Russian BMP-1 and BMP-2 which are vastly more proliferated than any other IFV and the BMP-2 can be easily considered the most prevalent threat IFV system in the world. China originally imported or produced copies of the BMP-2 for their IFV requirements but in recent years they have begun production of numerous indigenous IFVs the most important of which is the ZBD97. The ZBD2000 IFV is similar in design and capabilities to the US Expeditionary Fighting Vehicle (EFV) and the ZLC2000 is an airborne IFV similar to the Russian BMD series.

Figure 7 shows the APCs of interest worldwide. Many countries are producing APCs due to their relatively easy construction and there are many types that have proliferated to or are made by countries of interest to the US military. Table 3 contains data concerning the production parameters and proliferation of the APCs shown in Figure 7. Of particular note are the Russian BTR-80/82, the US Piranha, and the US M113. The M113 is by far the most produced and proliferated APC in the world and will remain in military inventories for years to come.

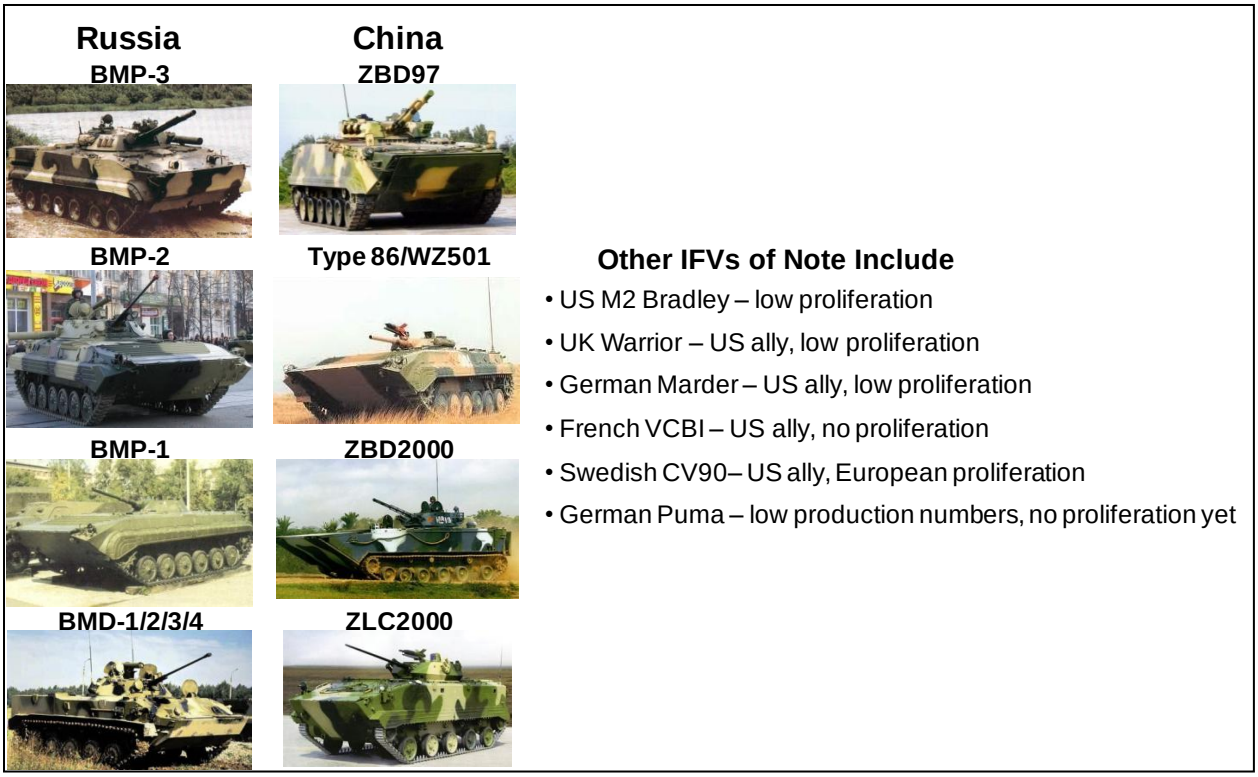


Figure 6. IFVs of the Top Two Producing and/or Proliferating Countries of Interest

Table 2. IFV Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
BMP-3	10/8	1500+	YES	YES	YES
BMP-2	39/24	11,000+	YES	YES	YES
BMP-1	60+/30	20,000+	NO	NO	NO
BMD-1/2/3/4	10/5	2000+	YES	YES	NO
ZBD-97	1/1	1000+?	YES	YES	NO
Type-86	1/1	1000+	NO	NO	YES
ZBD-2000	1/1	100+?	YES	YES	NO
ZCL-2000	1/1	100+?	YES	YES	NO

Figure 7. APCs of the Top Four Producing and/or Proliferating Countries of Interest

Table 3. APC Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
BTR-90	1/1	100+	YES	YES	YES
BTR-80/82	30+/16	5000+	YES	YES	YES
BTR-70	20+/6	5000+	NO	NO	NO
MT-LB	20+/5	9000+	NO	NO	YES
ZBD-09	1/1	100+	YES	YES	YES
Type 89	2/2	1000+	YES	YES	YES
Type 90	1/1	100+?	YES	YES	NO
Type 85	4/3	2000+	NO	NO	YES
Type 63	12/6	3000+	NO	NO	NO
Type 92	9/7	2000+	YES	YES	YES
Boragh	3/3	100+	YES	YES	YES
M113	60+/16	80,000+	YES	YES	YES
MOWAG Piranha	20+	5000+	YES	YES	YES

Figure 8 shows examples of the major surface to air missile (SAM) systems of interest. Many of the Russian systems shown have been in service for decades and can be expected to continue to be in service for years to come with the help of upgrades. Table 4 contains data concerning the production parameters and proliferation of the SAM systems shown in Figure 8. Possibly the most dangerous SAM system due to both capabilities and quantities is the Russian SA-10 of which the Chinese HQ-9 is a copy. For Army test requirements though, the SA-10 is not relevant as Army aviation is based around rotary wing aircraft and UAS. The SAM systems of relevance to Army test requirements are short range air defense (SHORAD) systems Figure 9 shows examples of the most relevant SHORAD systems. The systems shown are primarily from Russia and China but two of note are the Skyguard anti-aircraft artillery (AAA) system and man portable air defense (MANPAD) systems. The Skyguard AAA system is a highly capable and proliferated AAA system from Switzerland and there are numerous countries manufacturing MANPADs. Table 5 contains data concerning the production parameters and proliferation of the SHORAD systems shown in Figure 9.

Figure 8. SAMs of the Top Two Producing and/or Proliferating Countries of Interest

Table 4. SAM Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
SA-12	3/3	100+	YES	YES	NO
SA-10	16/16	1900+	YES	YES	YES
SA-15	9/9	200+	YES	YES	NO
SA-11	6/6	250+	YES	YES	NO
SA-13	20+/7	500+	YES	YES	YES
SA-8	15+/11	600+	YES	YES	NO
SA-6	20+/12	2000+	NO	NO	NO
HQ-9	1/1	100+?	YES	YES	YES
HQ-12	1/1	100+?	YES	YES	NO
HQ-7	1/1	100+?	YES	YES	NO

Figure 9. SHORAD Systems of Interest

Table 5. SHORAD Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
MANPAD	ALL	extensive	YES	YES	YES
2S6	5/5	400+	YES	YES	NO
Pantsir	5+/5	100+	YES	YES	YES
ZSU-23-4	40+/27	2000+	NO	NO	YES
SKYGUARD	30+/11	2000+	YES	YES	NO
ZSU-23-2	50+	10,000+	NO	NO	NO

Figure 10 shows artillery systems of interest worldwide. Artillery systems fall into the two main categories of self-propelled and towed. Modern self-propelled artillery systems from Russia, China, and Germany have the most capabilities but the M109 from the United States has been produced and proliferated in large quantities. In the towed artillery category the D-30 and copies of it is by far the most numerous and proliferated system. Table 6 contains data concerning the production parameters and proliferation of the artillery systems shown in Figure 10.

Figure 10. Artillery Systems of Interest

Table 6. Artillery Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
2S19	7/7	600+	YES	YES	NO
2S3	18+/10	3000+	NO	NO	NO
2S1	30/17	3000+	NO	NO	NO
D-30	50+/30	8000+	NO	NO	NO
PLZ05/05/45	4/4	100+	YES	YES	NO
PLZ07	1/1	100+	YES	YES	NO
Type 83	1/1	<78	NO	NO	NO
Type 89	1/1	100+	NO	NO	NO
Type 86	1/1	1000+?	YES	YES	NO
M109	40/12	5000+	NO	NO	YES
Raad-2	1/1	100+?	YES	YES	NO
Raad-1	1/1	100+?	YES	YES	NO
M198	12/6	1600	NO	NO	NO
PzH2000	4/4	350+	YES	YES	NO

Figure 11 shows multiple rocket launcher (MRL) systems of interest worldwide. MRL systems are highly proliferated and systems from Russia and China have the most capabilities. The Russian BM-30 Smerch of which the Chinese PHL03 is a copy has the longest range and firepower of current MRL systems. The Russian BM-21 and its derivatives is by far the most produced and proliferated MRL system in the world today and can be expected to be for the foreseeable future. Table 7 contains data concerning the production parameters and proliferation of the artillery systems shown in Figure 11. Iran is producing a number of unique MRL systems based on indigenously produced missiles and different truck chassis'. China has a relatively large number of MRL systems in inventory and production but proliferation of Chinese MRL systems has to date been relatively low.

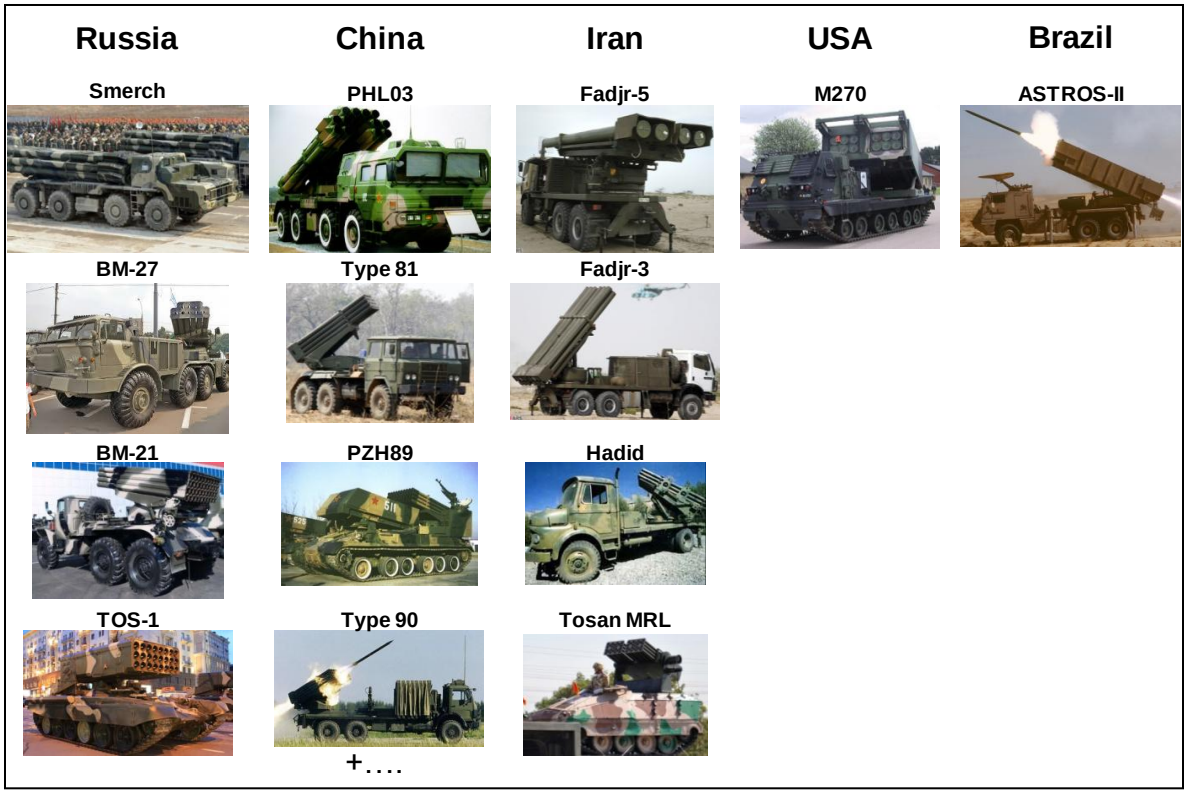


Figure 11. MRL Systems of Interest

Table 7. MRL System Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
Smerch	7/7	400+	YES	YES	NO
Uragan	15/5	1000+	YES	NO	NO
BM-21	60/38	5000+	YES	YES	YES
TOS-1	2/2	<100	YES	YES	NO
PHL03	1/1	100+?	YES	YES	NO
Type 81	1/1	1000+?	NO	NO	NO
PZH89	4/2	1000+?	NO	NO	NO
Type 90	1/1	1000+?	YES	YES	NO
Fadjr-5	2/2	100+?	YES	YES	NO
Fadjr-3	1/1	100+?	YES	YES	NO
Hadid	1/1	100+	YES	YES	NO
M270	13/1	1300+	YES	YES	YES
ASTROS	7/6	200+	YES	YES	YES

The final category of artillery targets is short and medium range ballistic missiles (SRBM/MRBM). Figure 12 shows multiple rocket launcher (MRL) systems of interest worldwide. Much like some of the SAM systems mentioned previously these systems are beyond the scope of the Army mission but are included here for completeness. Army aviation systems are not intended for long-range deep penetrations into enemy airspace but with the highly mobile nature of modern warfare and the long range of Army UAS elements it is possible that one of these systems could be encountered. Russian and China are prolific producers of these types of systems while Iran, Pakistan, and India are producing as well. The SS-21 and SS-26 SRBMs were used by Russia to attack Georgia in 2008 so there is a strong precedent for these types of missiles being used in combat in modern conflicts. Table 8 contains data concerning the production parameters and proliferation of the artillery systems shown in Figure 12.

Figure 12. SRBM/MRBM Systems of Interest

Table 8. SRBM/MRBM System Proliferation, Quantities, Production Status, and Projections

System	Users/Users of Interest	# in Existence	In Production?	Future Production?	Upgrades Available?
Scud B	26/12	???	NO	NO	YES
SS-21	11/6	400+	NO	NO	NO
SS-26	1/1	100+?	YES	YES	NO
FROG-7	10/8	1000+?	NO	NO	NO
DF-15	1/1	100+?	YES	YES	NO
DF-16	1/1	<100?	YES	YES	NO
DF-11	1/1	100+	NO	NO	NO
CSS-8	3/3	100+?	NO	NO	NO
CSS-X-11	2/2	<100?	YES	YES	NO
Fateh-110	1/1	100+?	YES	YES	NO
Zelzal	1/1	100+	YES	YES	NO
Shahab	1/1	<100?	YES	YES	NO
Hatf-1	1/1	100+?	YES	YES?	NO
Shaheen-1	1/1	100+?	YES	YES	NO
Shaheen-2	1/1	<100?	YES	YES	NO
Ghauri	1/1	<100?	YES	YES	NO
Prithvi	1/1	100+?	YES	YES	NO
Agni-II	1/1	<100?	YES	YES	NO

Combat support equipment (CSE) covers a wide range of possible targets and ranges from reload vehicles for SAM and MRL systems to earthmoving and engineering equipment. CSE is a critical element of warfare and even though it usually stays behind front line elements in combat, the pervasive use of UAS and their projected increased use in the future will mean that rear echelon systems such as CSE will increase in relevance as legitimate targets on the battlefield of the future. This trend of the increasing use of ISR and UAS assets bring up the need for including CSE elements in the testing process. For example, a SAM system is just that, a system consisting of many subcomponents. System elements can include radar vehicles, command and

control vehicles, mobile generators, and reload vehicles. When testing an ISR system it is important to include the complete system including all of the associated supporting components.

With the future Army focus on small footprint conflicts, counterterrorism, and counterinsurgency, no discussion of targets required for Army testing can exclude personnel, technical vehicles, and other weapon systems associated with asymmetric warfare. A historical mindset was that of "system-versus-system" in that tanks were being designed to survive on the battlefield and defeat other tanks. Recent conflicts have demonstrated that the least common battlefield denominator, a human combatant, is the primary driver for the majority of engagements and this trend can be expected to continue into the future. In counterterrorism and counterinsurgency operations these combatants will be using a mix of military and non-military vehicles and whatever weapons are at hand.

There are two factors to consider when discussing personnel targets, signature and lethality. If testing a system with a sensor it is important to ensure that the personnel target has a sufficiently accurate signature in all required signature regimes. If testing a system with a lethality requirement any target will need to have the physical properties required to conform to validated Army lethality models. The current army lethality model is based on simplified mannequins built using 0.75 inch marine grade plywood but future models may require other materials.

One important aspect of personnel targets relates to the definition of the term signature. As previously defined, he term includes the set of recurring features of *activities*. When developing sensors and weapon systems to deal with counterinsurgencies it will be important to have the capability to create realistic test events where there are personnel targets performing actions that are indicative of hostile intent. This results in the requirement for animated or mobile mannequin targets that can simulate activities such as IED emplacement or flight/evasion. It is plausible that in the near future there will be an Army test requirement for this type of personnel target for realistic testing against what has become the most common target on the modern battlefield.

It has been demonstrated over and over again in modern warfare that irregular forces will utilize any vehicle at their disposal for mounting and transporting crew-served weapons. The term used to describe this type of improvised military vehicle is "technical" and originated in the early 1990's in Somalia. Technical vehicle weapons can range from simple heavy machine guns to rocket launchers and AAA. Figure 13 shows examples from the Libyan revolution where revolutionary forces mounted AAA and rocket launchers on light trucks and even developed improvised mobile rocket launchers by mounting helicopter rocket pods on trucks. When dealing with irregular forces and technical vehicles and trying to derive Army target requirements from historical examples it must be remembered that any possible weapon system that can fit in any possible civilian truck needs to be considered. This inherent uncertainty and the inability to rigidly define a single type of weapon/vehicle combination must not be allowed to inhibit the technical target development process. Since any combination is possible, any

combination is inherently valid as a technical target representation. Certain trucks are more likely candidates than others and the most likely candidates will need to be assessed on a country by country basis. With the stated focus on South Asia and the Middle East a prime candidate for a technical vehicle is the Kia Bongo. This is a cost effective, heavy duty, readily available

vehicle in the geographical region of interest and has been commonly used for insurgent activities in recent conflicts.

Figure 13. Technical Vehicle Examples

As mankind develops more and diverse means of transportations in the future all of these transportation devices are candidates for military vehicles. The growth of the all terrain vehicle (ATVs) industry has resulted in their adoption as transport and weapon carriers by multiple nations. Both the Chinese and Iranian militaries have adopted ATVs and these are legitimate targets for future Army testing. Figure 14 shows examples of ATVs and motorcycles being used for military applications. These examples shown include an Iranian rocket-propelled grenade (RPG) team, an ATV-mounted MRL, and Special Forces.

Figure 14. Military Applications of ATVs

4.2.2 FSU Ground Systems.

The FSU is the primary developer of potential targets for the US Army due to its well-developed military industrial complex and its need to support its struggling economy with whatever export sales it can possibly generate. The FSU has produced tens of thousands of armored vehicles over the duration of the cold war and has maintained its military industrial base even though current annual production quantities are orders of magnitude lower than in the past. Figure 15 shows examples of the wide range of FSU ground vehicle systems which cover every possible category or modern military ground system.

Figure 15. FSU System Examples

While Russia and members of the FSU are by no means probable US ground war opponents for the foreseeable future, their military products are still the number one candidates. The decades

of arms exports by the FSU during the cold war and the continued marketing of their military products keeps their weapon systems in the forefront of any US Army target requirements analysis. Due to the sheer numbers of legacy systems such as the T-72, traditional FSU weapon systems will remain relevant for decades. As an example, in the recent Libyan conflict T-55 MBTs were commonly used even at their venerable age of over fifty years. However, in order to fully stress US Army developmental systems the most modern equipment must be acquired if there is a strong probability that it will be encountered on the battlefield in the future.

Figure 16 shows examples of Russian and FSU systems that will be most relevant to Army testing over the next two decades. The systems and reasons for relevance include:

- T-90AM – highly capable upgrade of T-90, relatively inexpensive, strongly marketed for export
- BMP-2M – huge numbers of BMP-2s in world inventories and this upgrade will provide greatly improved capabilities over a standard BMP-2 at low cost and without the need for changing an existing logistics system
- BTR-80/82 – wheeled FSU APCs have been a fixture on modern battlefields in regions of interest and this system represents the version most likely to be produced and proliferated in the future
- SA-15 – extremely capable SAM system for low-flying aircraft which has been proliferated to countries of interest such as China and Iran
- Pantsir/2S6 – most capable SAM/AAA system in the world and offered for export
- ZSU-23-2 – huge numbers of these AAA systems have been proliferated and can be expected to be encountered in almost every country of interest
- BM-30 Smerch – most capable MRL system in world and being copied by the Chinese
- BM-21 Grad – most proliferated and copied MRL system in world
- D-30 – most proliferated and copied towed howitzer in world

Figure 16. Example FSU Systems Of Future Interest

4.2.3 Chinese Ground Systems.

China is a primary developer of potential targets for the US Army due to its well-developed military industrial complex and its geographical and political relevance to future strategic Army plans. China was once a major importer and duplicator of FSU weapon systems. In the last few decades China has greatly increased its manufacturing technological capabilities and this, combined with a rapidly expanding economy has resulted in a military industrial complex comparable to any other first world country. An advanced military industrial capability combined with China's long history of being willing to export anything and everything results in them being a major player in populating the battlefield of the future. Figure 17 shows examples of the wide range of Chinese ground vehicle systems which cover every possible category or modern military ground system.

Figure 17. Chinese System Examples

Chinese ground weapon systems can be divided into two main categories with regards to Army target requirements analysis: legacy FSU systems, and modern Chinese-designed systems. There are many Chinese armor and artillery systems that are either direct or close copies of older FSU systems. These systems such as the Type 69 MBT no longer exist in large numbers in Chinese military inventories and are being phased out and replaced by modern, Chinese-made systems. The main systems that the Chinese military is still closely copying from modern Russian systems are SAM systems such as the HQ9 (SA-10 copy) and the SA-15. Other than a few systems like this the Chinese military of the future will be almost exclusively armed with Chinese designed and manufactured systems. With the strategic military shift of focus to Asia, the emergence of China as a major weapons producer, and China's inclination for export, Chinese ground systems will have an increasing relevance from 2020 and beyond.

Figure 18 shows examples of Chinese systems that will be most relevant to Army testing over the next two decades. The systems and reasons for relevance include:

- Type 99A2 – premier MBT and in production
- ZBD-97 – most capable IFV and in production
- Type 89 APC – ubiquitous APC produced with many variants that fill many roles in Chinese ground forces
- ZBD-09 – latest wheeled Chinese APC and offered for export
- HQ-7 – newest low altitude SAM system
- PGZ-95 – dual SAM/AAA system which is a rotary wing threat

- PLZ 04/05/45 – highly capable SPH with successful export history
- SA-15 – purchased from Russia and likely to be copied
- PHL03 – highly capable copy of Russian BM-30 Smerch
- Type 81 MRL – copy of Russian BM-21 (different chassis)
- Type 86 – copy of Russian D-30 towed howitzer
- Type 92/WZ-551 – highly produced and proliferated APC with many variants

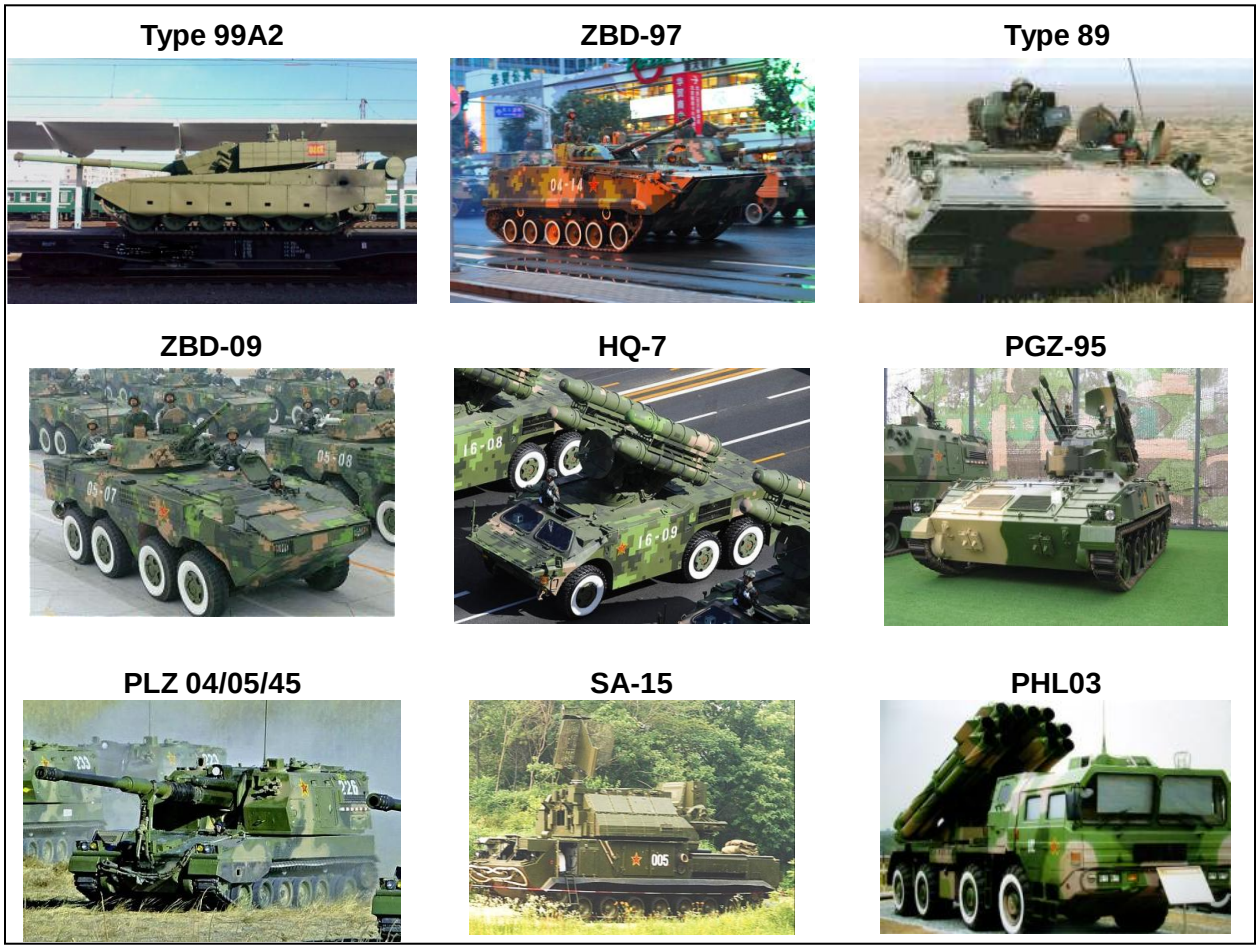


Figure 18. Example Chinese Ground Systems of Future Interest

4.2.4 Iranian Ground Systems.

Iran only has a relatively limited military industry but it is developing manufacturing capabilities for a variety of indigenous weapon systems. Anything in Iran is a potential target for the US Army due to its geographical and political relevance to future strategic US military plans. Iran was once a major importer and of US weapon systems weapon systems and still has many in inventory and these have been replaced and augmented with FSU and indigenous systems in recent decades. Figure 19 shows examples of Iranian ground vehicle systems.

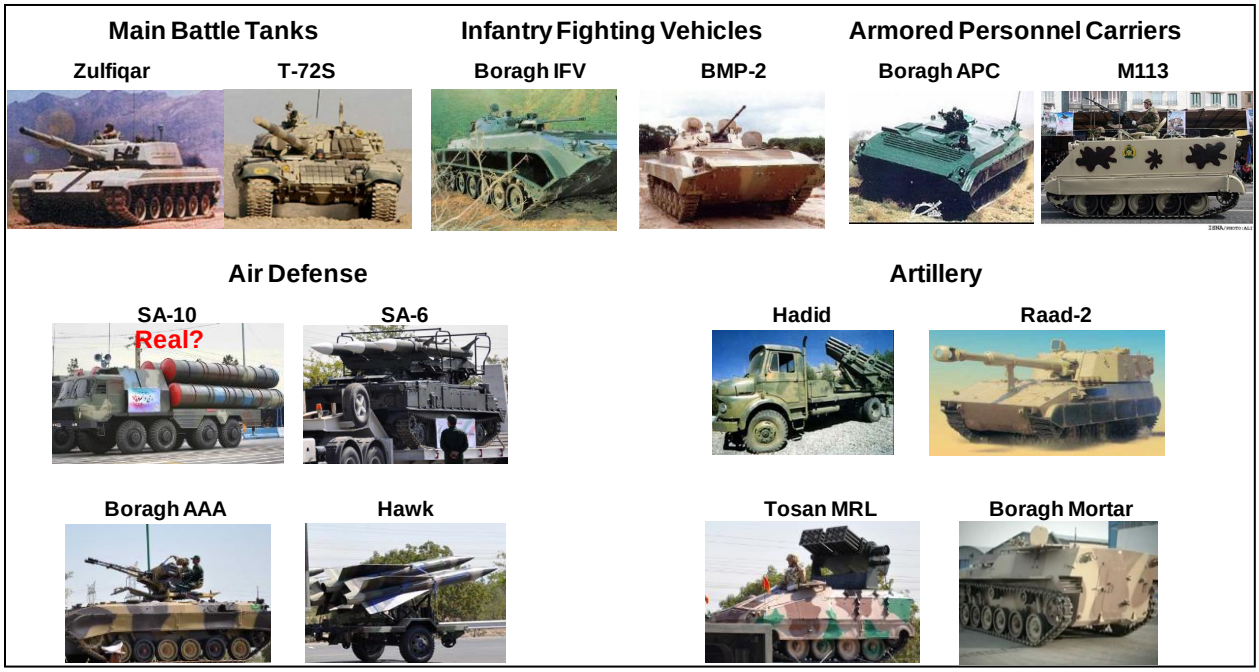


Figure 19. Iranian System Examples

Current Iranian ground weapon systems can be divided into three main categories with regards to Army target requirements analysis: legacy US systems, current FSU systems, and Iranian-designed systems. The majority of Iranian systems, especially when considering the long term, will be from the FSU, FSU-derived designs, or possible modern Chinese systems. While Iran is developing indigenous armored vehicles such as the Boragh IFV and the Zulfiqar MBT these are being produced in small quantities. The main focus of recent Iranian military technology development has been focused on SRBMs and MRBMs as these have strategic significance for controlling oil shipments in the Persian Gulf and can threaten Iran's traditional ally Israel. With the strategic military shift of focus to Asia and the Middle East, the emergence of Iran as a potential nuclear weapons producer, and the ever present tension between Iran and Israel, Iranian ground systems will have an increasing relevance from now until 2030.

Figure 20 shows examples of Iranian systems that will be most relevant to Army testing over the next two decades. The systems and reasons for relevance include:

- T-72S – most capable Iranian MBT in any meaningful quantity
- BMP-2/Boragh IFV – effectively equivalent systems, main Iranian IFV
- Boragh APC – indigenously produced IFV
- SA-15 – most capable imported SAM system
- SA-6 – very capable imported SAM system
- M113 – legacy APC but still in inventory

- Hadid – BM-21 copy
- Fadjr-3/5 – indigenously produced MRL expected to be in inventory for decades

Figure 20. Example Iranian Ground Systems of Future Interest

4.3 Counterterrorism and Counterinsurgency T&E Target Requirements

The most long-term, ubiquitous, and relevant target class for future Army testing is personnel targets. Personnel are the lowest common denominator in any potential future conflict and the strategic shift to counterterrorism and counterinsurgency operations shifts the focus to personnel targets even more. Personnel targets are common and readily available for training purposes and for visible spectrum EO sensors common training mannequins can be sufficient to meet test needs. Current and future Army sensor and weapon system testing will require validated personnel targets which could consist of full three-dimensional (3-D) mannequins or a lesser detailed target such as a silhouette. Future personnel targets will need to be augmented to have the correct signatures to properly stimulate sensors being tested and these personnel target

signatures will have to be validated in accordance with the guidelines listed in DA PAM 73-1 Appendix Z.

Along with the personnel targets themselves they will require accessories and auxiliary equipment to properly create the complex signatures of small units of irregular forces performing irregular warfare activities. These accessories will consist of remote controlled technical vehicles, crew-served weapons, MANPAD simulators, and regionally accurate culturally specific clothing. A current and near-term Army test need is for hostile fire indication (HFI) and for hostile fire detection systems (HFDS). Testing these types of systems will require actual weapon systems firing at US sensor platforms or accurate, validated simulators capable of producing the EO signatures of firearms, crew-served weapons, and missile launches.

For the purposes of this report both counterterrorism and counterinsurgency operations will be referred to as irregular warfare. Figure 21 shows examples of the types of irregular warfare targets that will need to be available as Army T&E assets for testing sensors and weapon systems over the next two decades. A valid irregular warfare target can consist of anything ranging from a simple 3-D mannequin with no weapons to a technical vehicle mounting a crew-served weapon and multiple mannequins. Any possible combination of appropriately garbed personnel, common small arm, regionally available crew-served weapon, and regionally available light truck or off-road vehicle could result in a valid irregular warfare target. Representations of both combatants and non-combatants will be required due to the increasing importance of minimizing civilian casualties and collateral damage. A more detailed irregular warfare target parameter list might include:

- personnel – both male and female over a range of ages wearing either civilian or military clothing
- small arms – from pistols and civilian weapons to the ubiquitous AK-47
- explosives – from hand grenades and mines to conflict-specific IEDs
- anti-tank and anti-aircraft weapons – RPGs and MANPADs
- crew-served weapons – heavy machine guns, mortars, MRLs, and light AAA
- technical vehicles- ATVs and off road vehicles to light duty commercial trucks

An ever-increasing factor in US military doctrine and system development is the requirement to be able to determine the intent of a person or group of persons as a person or group of people are performing an activity. The ability to represent personnel target features such as hidden weapons will require high-fidelity mannequins with high-fidelity representations of the accessories mentioned above.

Figure 21. Targets Relevant To Testing Army Systems Intended For Counterterrorism and Counterinsurgency Operations

4.4 Target Surrogate Concepts

All of the target requirement discussions presented so far in this report have covered proposed target requirements but have not addressed the fiscal and political realities of actually acquiring these targets and maintaining them as a an Army test capability. When a program has a test requirement for a target representation that is not affordable or available for use at US test ranges some form of surrogate must be used. Surrogates can range from actual threat or US systems with similar signatures and properties to the required threat system, to custom-designed manufactured surrogates that have had their signatures and capabilities validated and accredited for a specific test case.

Examples of using actual systems to surrogate required threat systems could include:

1. upgrading a threat system to a newer model of the same system such as upgrading a BMP-2 in US inventory to a BMP-2M by adding actual accessories acquired from a foreign manufacturer
2. upgrading a threat system by designing and fabricating surrogate accessories such as upgrading a T-72B in US inventory to a T-90AM
3. using a surplus US system as a threat surrogate

4. designing, manufacturing, and validating alternative threat surrogates from the ground up

Each target surrogate development approach mentioned above has advantages and limitations and each must be assessed on a case-by-case basis in regards to cost, schedule, and technical risk. Figure 22 shows the relative risks associated with each type of target surrogate approach listed above for the categories of cost, schedule, technical, and validation risk.

Surrogate Approach	Cost Risk	Schedule Risk	Technical Risk	Validation Risk
1 – Upgrading with real accessories	M	M	L	L
2 – Upgrading with fabricated accessories	M	M	M	M
3 – Using US systems	L	L	L	H
4 – Designing and building surrogates	L	M/H	M/H	M

= High risk = Moderate risk = Low risk

Figure 22. Risk Assessment for Different Target Surrogate Approaches

Ever increasing budgetary constraints will make surrogate targets a much more important way to meet test requirements in the future. Of the four approaches mentioned above options 2-3 have historical precedents as a successful target surrogate approach. Options 1 and two are the two lowest risk approaches but require the existence of a baseline target platform to upgrade into a modern threat platform. These approaches require research, design, fabrication and installation in coordination with the intelligence community for threat definition and a test range where the fabrication and assembly can be accomplished. While these options can present a challenge the option 2 approach was successfully executed on the T-90 surrogate effort where an older model T-72 was upgraded to a T-90 surrogate with the addition of external accessories. Utilizing US surplus vehicle assets as target surrogates offers many advantages but only if the threat representation requirements are minimal. If a test only requires a target that can be identified as a "military tracked or wheeled vehicle" and engaged during a test then this may be an acceptable approach.

The final approach of designing and building custom surrogates is one that has multiple successful precedents. While a multi-year, multi-million dollar target surrogate development effort may initially seem expensive; the program cost can be easily offset over a short time if multiple actual threat vehicles can be replaced with surrogates during testing. Modern threat systems are becoming more and more complex and are no longer "dumb lumps of metal" that can be inexpensively acquired on the international surplus vehicle market or from second and third world countries where they were exported to. If test requirements can be determined early

enough in the life of a program target surrogates can be designed, fabricated, tested, documented, and validated to meet program test needs with significant cost savings to a program.

There are other ways for creating target surrogates than the approaches mentioned above. Depending on test requirements it should be possible to address target requirements on a target-by-target basis and find alternatives to having to acquire the exact threat system as specified in a program's TEMP. A simple example of this is the Iranian Boragh IFV which is just an indigenously-produced copy of a BMP-2 with some minor changes in the fender materials. If Iran turns out to be a high priority country of interest in the future and the target requirements process defines "Boragh IFV" as a target, a requirements analyst in the decision chain will need to identify the BMP-2 as a suitable surrogate. This concept leads to the natural conclusion that the identification of surrogate targets be an integral part of the development of TEMPs in the future. It is common practice for the intelligence community to identify the targets required to represent a future battlefield environment but with coordination with the test community it may be possible to meet test needs at reduced costs with forethought and coordination.

4.5 Multi-Service Ground Target Requirements

While determination of multi-service target requirements is not the purpose of this report they will be briefly discussed to identify cross-service leveraging opportunities. Current Air Force programs such as the SDB program have existing target requirements and any follow-on Air Force weapons programs will likely have similar requirements. Air Force sensor programs could also take advantage of Army target inventories but will unlikely have the need for APS's or fully functioning electronics to test Air Force weapons. SAM systems including the longer range SAMs beyond the Army's interest will always be the primary ground target of interest for Air Force platforms.

The Navy and Marine Corps will have target requirements as Naval Aviation testing is often against ground targets similar to those needed by the Army but like the Air Force, SAM systems will be of much greater relevance. The Marine Corps should be developing some type of replacement for the Expeditionary Fighting Vehicle (EFV) over the next decade and it could require IFV and APC targets. The Marine Corp is also testing non-lethal weapon systems and this will likely turn into a long term requirement.

4.6 Ground Target Camouflage, Concealment, and Deception Requirements

Camouflage, concealment, and deception (CC&D) has been a part of warfare for millennia and remains an important component of modern warfare. With constant overhead surveillance by US satellites CC&D can play a major role in strategic deception as well as the traditional tactical role that it plays. The most prevalent CC&D technologies relevant to Army target requirements are camouflage systems and decoys. Camouflage systems include camouflage netting (both canopy and fitted) and impact both EO and RF signature regimes. Decoys can range from field-expedient vehicle representations made from locally available materials to high fidelity engineered decoys. Decoys can also include signal emitters for radar and other EW assets. It is beyond the scope of this report to even attempt to provide a comprehensive overview of CC&D techniques commonly deployed in tactical situations. However, CC&D techniques will be broadly covered to provide definitions of terms. In a simplistic CC&D sense, camouflage can mean many things involving both treatments to the vehicle and concealment of the vehicle. For the purposes of this report, camouflage is defined as some form of modification or treatment applied directly to a vehicle such as paint, fitted netting, or foliage. Concealment will be defined as employing terrain, natural vegetation, or materials to deny observation of a vehicle, and deception means that something other than an actual vehicle is being used to represent a vehicle. Figure 23 shows examples of camouflage, concealment, and deception as defined for this report. To add even more complexity to the problem, a possible example of four simultaneous methods is a camouflage painted and netted vehicle that is placed under a camouflage net in an earthen berm (or under trees). Some of the common CC&D combinations are pointed out in Figure 23.

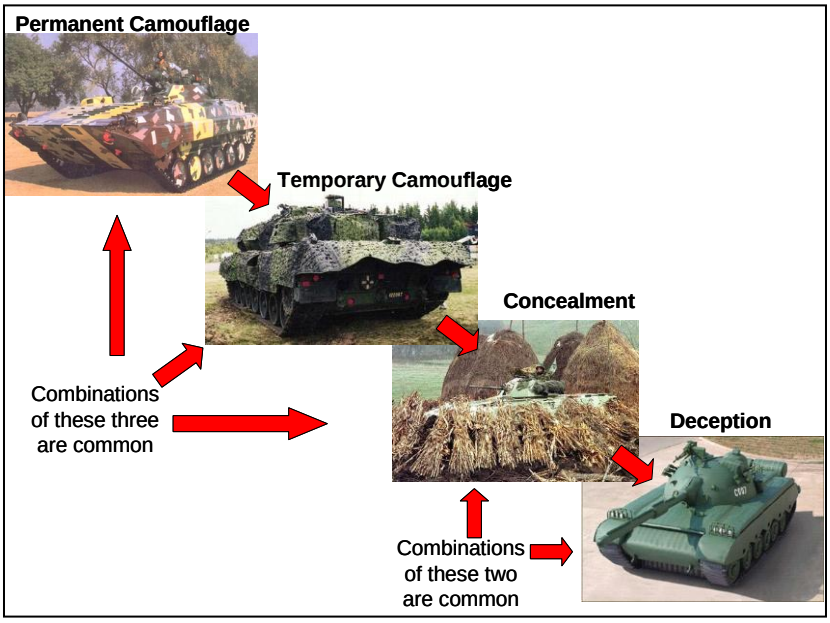


Figure 23. Camouflage, Concealment, & Deception Definitions.

Camouflage on vehicles in actual combat is the norm rather than the exception, and there are a number of things that can be done to reduce a target's detectability on a battlefield and enhance its survivability. These range from field-expedient methods using locally available vegetation and materials to highly engineered signature management treatments. Figure 24 shows the range of signature modifications that can commonly occur on ground vehicles. A true baseline vehicle in standard configuration is the starting point for all the possible real-world signature variations and it is highly unlikely that a true baseline vehicle ever exists outside of a military unit's motor pool. Seeing a perfectly configured vehicle with no parts missing or added is almost an impossibility on a real battlefield, but the signature definition process must start with the simplest, most representative case. After the bare vehicle the most common signature modification process is the addition of the normal combat kit for the vehicle which in some cases can have an unintentionally significant effect on a vehicle's signature. The first type of intentional signature modification for a vehicle is the field-expedient addition of locally available materials (natural or man-made) that could reduce the thermal contrast of the vehicle or change its silhouette and make it less easily identified. Common techniques that fall into this category are the application of mud or foliage, or items such as sandbags or wet burlap sacks. Field applied camouflage netting and other more labor intensive signature treatments using man-made materials such as surplus conveyor belts are common examples of the next level of complexity of vehicle signature modifications. The final level of vehicle camouflage is the highly engineered signature management treatments which can range from custom designed camouflage netting to special paints and vehicle add-on kits. All of these different techniques represent a gradually decreasing target contrast that is representative of actual reality on the modern battlefield.

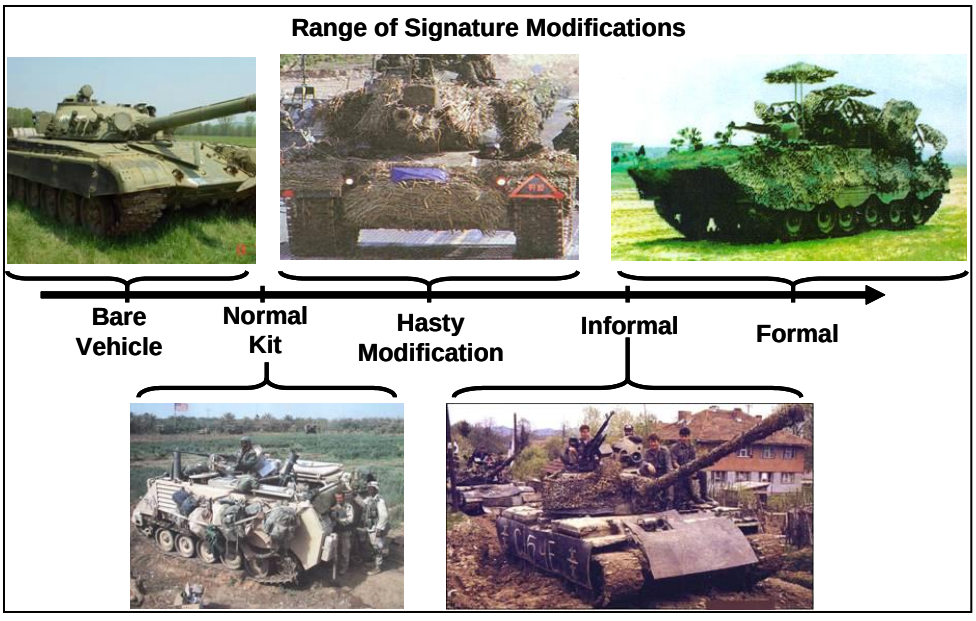


Figure 24. Definition of CC&D Signature Variations for a Ground Vehicle

A realistic battlefield environment in an operational test (OT) should not just consist of just "sitting duck" targets in the open waiting to be detected by an approaching SUT and shouldn't just consist of a tank hunt with 2-3 tanks rolling down a road in open terrain. For proper testing an OT needs to be the complete scenario with foreign military operational tactics involved and *CC&D is the rule not the exception.* Sensors on US military systems no longer need to just identify a target but they need to be able to tell targets from decoys. CC&D impacts on Army target requirements included doctrinal changes to OT to include target signature modifications shown above as well as the acquisition of foreign decoys or the development of generic US-made surrogate decoys.

The two countries of greatest interest in this report, Russia and China, have significant CC&D technology and assets and can be expected to deploy decoys and camouflage in almost any conceivable tactical scenario. China in particular can be expected to deploy advanced CC&D assets as they have the highest fidelity decoys seen to date. Larger Chinese military units have dedicated CC&D components whose only purpose is to deploy advanced camouflage and decoys. Figure 25 shows examples of Chinese decoys. Chinese decoys range from relatively simple inflatable decoys to highly advanced metal tank decoys that are threat representative to visual and radar sensors. Other advanced Chinese decoy technology shown in the figure are truck-mounted missile launcher decoys that include missile launch plume signatures.

Figure 25. Chinese Decoy Examples

Russia and other countries in the FSU have a long history of CC&D technology development including inflatable targets and high-fidelity trailer mounted targets. Figure 26 shows examples of recent decoy technologies manufactured by Russia and countries of the FSU. The top four Russian decoys shown are all inflatable and include SAM system decoys and MBT decoys. The bottom decoy is manufactured in Belarus and deploys from its own trailer into a full-scale MBT decoy similar in concept to the high-fidelity Chinese tank decoy shown in Figure 25. The manufacturers of these decoys have offered them for sale on the international arms market and proliferation of these types of decoy technology is a strong possibility in the future.

Figure 26. FSU Decoy Examples

5.0 CONCLUSIONS

The Army target requirements conclusions that can be drawn from the data presented in this report include:

1. Upgraded Russian armored systems such as the T-90AM, the BMP-2M, and the BTR-82 will be relevant Army targets in the future,
2. Russian SAM systems will remain relevant over the period covered by this report,
3. Chinese systems will be increasingly relevant with the shift of US military focus to the Asia-Pacific region and the rapid development of China's military industrial complex,
4. There will be an overall shift of Army target priorities to irregular warfare targets such as personnel and technical vehicles including testing against these types of targets in urban environments,
5. Targets acquired for Army testing will need to have complete computerized control and communication systems for testing cyber warfare tactics and this will require closer coordination with the intelligence community,
6. Armored vehicle targets acquired for Army weapon testing will need to have complete and functional APS systems and this will also require closer coordination with the intelligence community,
7. Surrogate targets will continue to play a role in Army testing as future test budgets will be stressed to provide actual threat targets for testing,
8. CC&D assets such as decoys and camouflage systems will be needed for replicating threat battlefield tactics in an OT environment.

6.0 RECOMMENDATIONS

The recommendations provided by this report include the following:

1. Future Russian armored vehicle systems such as the T-90AM, BMP-2M, and the BTR-82 will be required and could have surrogates created of them by designing and fabricating accessories for targets currently in Army inventory or by acquiring relatively inexpensive older models of the base vehicle and upgrading their signatures with accessories in the US,
2. Advanced Russian SAM systems are difficult to acquire for testing and would be expensive to acquire and maintain if available, developing surrogates of advanced SAM systems such as the SA-15 is a viable alternative to meet future Army test requirements at reduced cost,

3. Chinese targets should be acquired for testing to include the full range of ground vehicle systems,
4. Technologies for advanced personnel and irregular warfare targets will need to be developed to meet Army counterterrorism, counterinsurgency, and close quarters (urban) test requirements,
5. Hostile fire simulators will need to be included on future target platforms (either actual or surrogate) for testing hostile fire detection systems,
6. A strategic plan will need to be developed for future battlefield testing of US cyber warfare technologies and practices,
7. A plan will need to be developed for the acquisition, maintenance, and deployment of threat armored vehicles with APS systems,
8. When developing program TEMPs planners will need to not only identify threat target requirements, but potential surrogates on a per-target basis for Army testing to reduce future test costs,
9. Programs will need to identify target limitations early in a program to provide lead time for the highest-fidelity and low-cost surrogate target options to be developed in time to meet test needs,
10. CC&D assets and procedures will need to be incorporated into future test events and the current CC&D inventory increased or surrogated.

7.0 REFERENCES

1) "Sustaining US Global Leadership: Priorities for 21st Century Defense", January 5, 2012

2) "Secretary of the Army Top Priorities", February 9, 2012